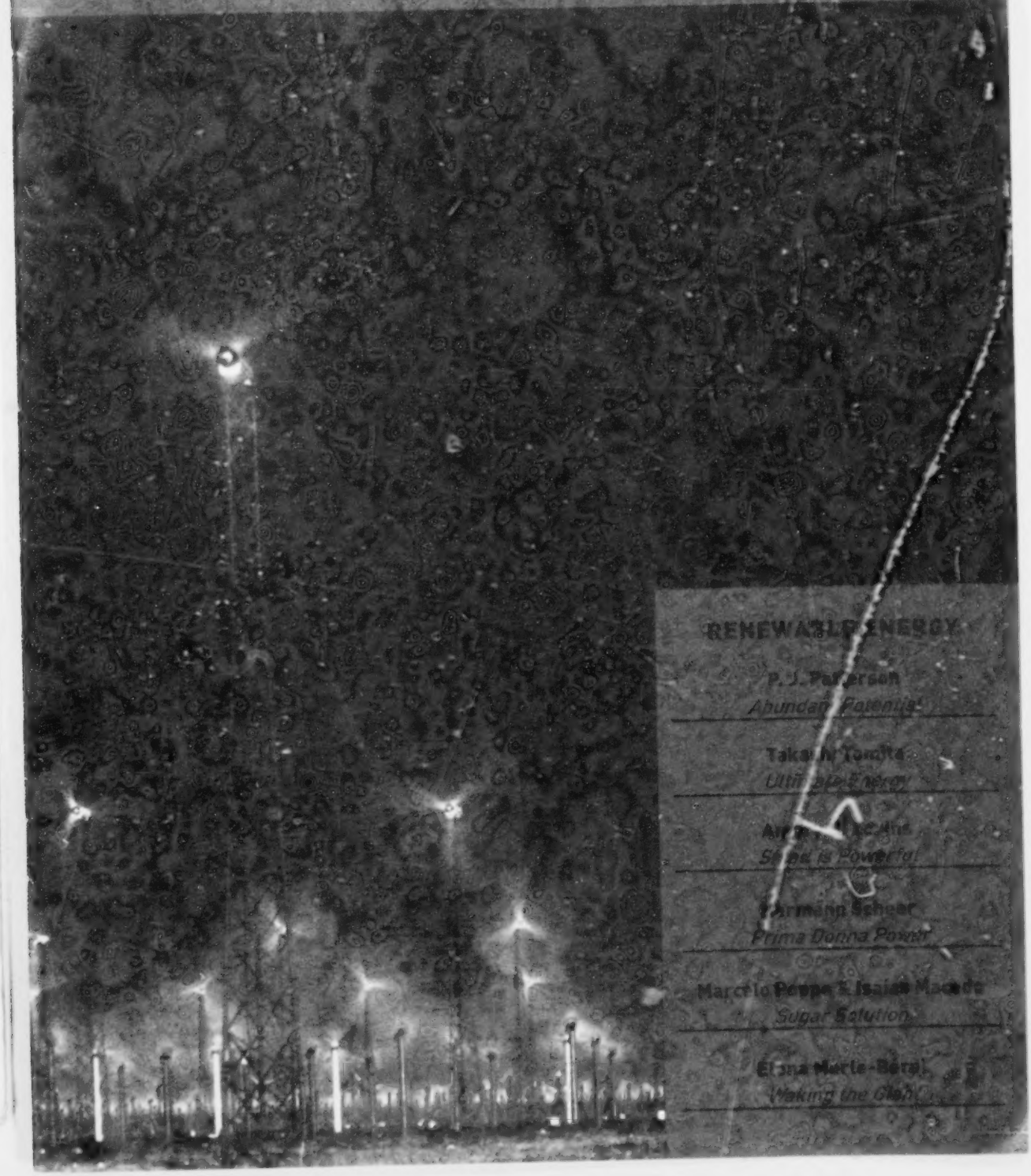
UNEP

Our Planet

Volume 16 No 4

The magazine of the United Nations Environment Programme



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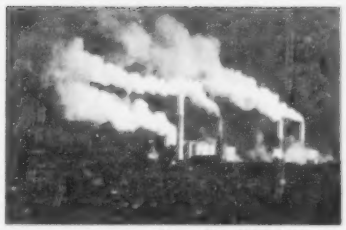

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Georg Boehling/Still Pictures

Also available on the internet at www.ourplanet.com

Our **Planet**, the magazine of the **United Nations Environment Programme** (UNEP)
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ISSN 101-7394

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Design: Shaun Cheema
Production: UNEP/DCPI
Printed by: Progress Press, Malta
Front cover: Peter Lewis/UNEP/Topfoto

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From the desk of

KLAUS TOEPFER

United Nations Under-Secretary-General and Executive Director, UNEP

Across the developing world, countries are beginning to see the way the wind is blowing. Once it was believed that only one per cent of their area was suitable for windpower. Now new satellite and computer modeling under the UNEP Solar and Wind Energy Resource Assessment, shows some nations enjoy much greater potential. Forty per cent of Nicaragua, Mongolia and Vietnam are suitable for example and could provide as much as 40,000 megawatts in capacity — the equivalent of 40 nuclear power plants.

Potential projects

The findings of the almost $10 million project with funding from the Global Environment Facility are already shaping development policies. Nicaragua's National Assembly has decreed that wind power should be given priority over other options, while China has used them to boost its windpower target to 20 gigawatts by 2020.

Amid many important decisions at December's climate change talks in Montreal, Canada, Governments agreed to strengthen and streamline the Clean Development Mechanism (CDM). One of the pillars of the Kyoto Protocol, this allows developed countries to offset some of their greenhouse gas emissions through projects — including renewables — in developing ones. It is clear from the Assessment that there is no shortage of potential projects.

The economics of renewables are improving. The cost of generating electricity from wind is somewhere around five cents a kilowatt hour, with solar and wave power costing some 18 to 20 cents. These figures are considerably lower than a decade or so ago but generally still higher than those for conventional fossil fuels. But they are only part of the story.

Economic argument

Many developed countries have enacted measures that weight the economic argument towards less carbon intensive energy generation. New business models are emerging that favour renewables, partly to exploit higher and more volatile oil prices. Some new energy companies in the United States, for example, offer big retailers fixed-price electricity contracts in return for installing and maintaining solar panels on the roofs of their supermarkets and warehouses. Moreover, though solar electricity may be more expensive, its price is relatively stable – often a big attraction.

Huge interest

New technologies are making it easier to manage and maximize the advantages of renewables. Newly developed meters allow power companies to charge more during the heat of the day when electricity demand is highest — and when solar generates most electricity. Wind turbines taller than 80 metres — able to catch higher and more stable winds — have also been developed. And the decline in agricultural subsidies is triggering huge interest in biofuels for blending with traditional vehicle fuels. These developments both save carbon and create new jobs and industries: some half dozen new silicon wafer factories are being built around the world to support the boom in solar panels.

The Montreal meeting also opened the door for the CDM to take up energy efficiency activities arising, for example, from deliberate public sector measures or private sector initiatives — a potentially significant development in areas from housing to transport. The World Energy Outlook 2004 estimates that energy efficiency alone could account for close to 70 per cent of the energy-related emission reductions "attainable through policies and measures in developing countries."

Concrete proposals

Many developed nations use about 45 per cent less energy to generate each unit of GDP than in the 1970s, yet there are huge opportunities to go much further. To take just one example, the standby power of electrical appliances ranges from 0.5 to 10 watts. The International Energy Agency believes this could be standardised at one watt — saving an estimated five to ten per cent of total electricity used in developed country homes.

I believe that in Montreal we got back the political will, creativity and flair needed to progress the fight against climate change. Energy will be central to our discussions at the 9th Special Session of UNEP's Governing Council/Global Ministerial Environment Forum in Dubai, which coincides with this issue of Our Planet. I hope that, in the same spirit, we can take the debate forward there, and back it with creative and concrete proposals ■

YOUR VIEWS

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Abundant *Potential*

P. J. PATTERSON

describes how developing renewable sources and energy conservation is charting his country's sustainable energy future

Jamaica is one of the highest energy intensive user countries in the Caribbean, currently 90 per cent dependent on fossil fuel sources to meet its needs. In 2004, it consumed 26.1 million barrels of imported oil valued at $943.4 million, approximately 23 per cent of the country's GDP. The high cost of oil in the international market means the cost of importing it is projected at $1billion for 2005. This, coupled with the country's pattern of energy consumption, is unsustainable and presents a major challenge to our social and economic development, as well as the business competitiveness of Jamaica.

At the national level, the impacts have adversely affected the levels of foreign exchange, rates of exchange, inflation, transport, production, national and regional airline viability — and the very quality of life for citizens.

Energy policy

Jamaica has focused on three major approaches in dealing with its energy needs: an energy diversification programme; energy conservation and efficiency; and renewable energy development.

In 2000, a major target of the government's Energy Policy was to produce 12 per cent of electricity requirements from renewable energy sources by 2020. This strategy of small-scale distributed energy was aimed partly at the rural poor who could not access the national grid. Renewables, seen as an insurance hedge against volatility and risk, now provide 5.6 per cent of the country's energy. The environmental benefits of using them are critical to a country like Jamaica where the main foreign exchange earner is tourism. Sound environmental stewardship of the country's natural resources, already subject to major natural disasters, is an important priority.

Renewable sources

Jamaica has abundant potential for the development of its renewable energy resources, including wind, biomass, mini-hydro, photovoltaic and solar energy. Some have been tapped at a minimal level in the past and could provide greater energy requirements with the use of appropriate technology and financial investments.

Central to the energy policy is the use of cogeneration technologies. They are already exploited by some in the hotel industry and manufacturing, but there is growing consensus that the greatest potential comes from the ailing sugar industry. New international trade rules demand drastic changes in this industry, and these will include energy production for electricity generation and ethanol production for use in the transport sector.

Wind energy

Disused windmills from Jamaica's plantation era show that wind energy has been used in the past, and research indicates that the potential is there for future exploitation. Since 1995, the Petroleum Corporation of Jamaica has conducted wind speed assessments at various sites. Wigton in the parish of Manchester proved to be most feasible and a 20.7 MW wind power plant was constructed. Twenty-three turbines producing 900kW were commissioned in late April 2004, and now supply the Jamaica Public Service with an average 7 MW of power.

The Executive Board of the Clean Development Mechanism approved and published in September 2004 a new "Consolidated Baseline Methodology For Grid-Connected Electricity Generation From Renewable Sources" for renewable energy projects. It has been developed by combining the techniques of different individual CDM proposals, of which the Wigton Wind Farm is one.

Jamaica has a high solar radiation of approximately 5 kWh/m2 per day, or 1,800 kWh per annum, and has market potential for photovoltaic and other solar applications such as solar water heating, electricity generation and solar crop drying.

Solar water heaters (SWH) have been installed in approximately 20,000 of Jamaica's 748,329 homes, and are estimated to save about 2000 kWh of electricity per residence per year. An extensive programme of installing solar water heaters in public hospitals is being undertaken. In the private sector, the hotel industry has begun a major use of

Jamaica has abundant potential for the development of its renewable energy resources, including wind, biomass, mini-hydro, photovoltaic and solar energy

solar water heating systems in an effort to green their businesses.

Second to solar water heating is the use of photovoltaic technology (PV). Photovoltaic applications, although requiring high initial capacity outlay, are encouraged through tax incentives. Current oil prices will make PV even more competitive. Jamaica is also moving to a regime of encouraging net metering.

Two photovoltaic villages, comprising 45 homes in rural Jamaica, were developed in 1999 with World Bank assistance. Established for approximately $1700 per household, each was supplied with 120 watts of power in an individual stand-alone system that covers inverter, power converter and battery, and accessory equipment.

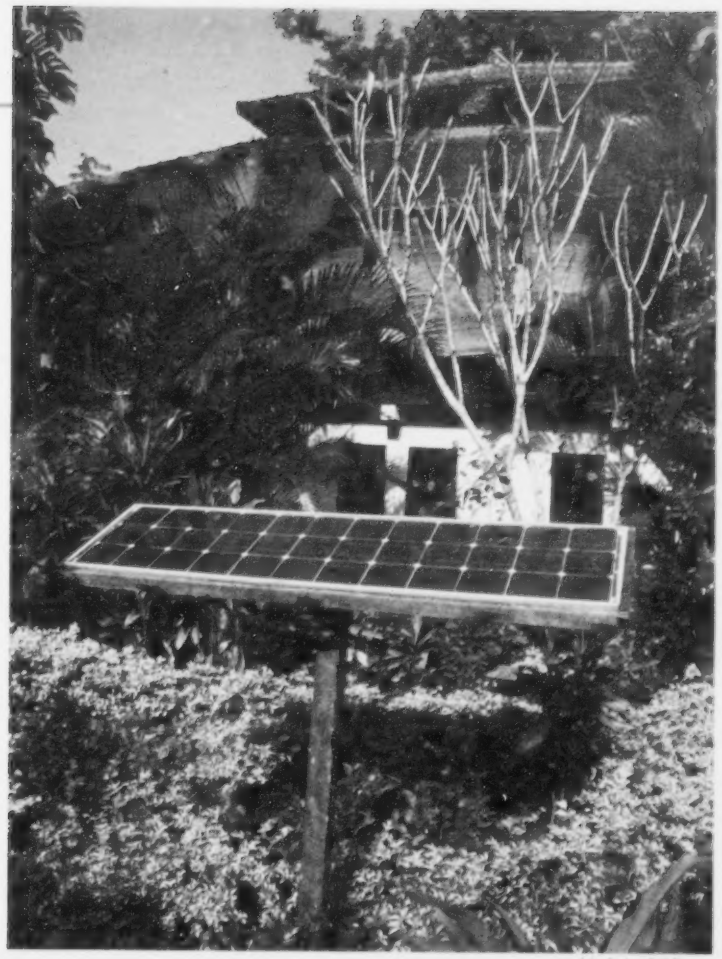
It is estimated that another 100 homes in Jamaica are fully solarised. The Scientific Research Council has employed simple technologies to develop a solar dryer that is used by farmers and others for some of their produce.

Energy technologies

Jamaica has various rivers suitable for the exploitation of small-scale hydropower. Small-scale electricity generation by using run-of-river plants has been in operation for over 100 years. Jamaica was one of the first countries in the world outside the United Kingdom to install a hydro plant, just outside Spanish Town in the 1890s.

The Public Utility Company currently operates eight mini-hydro plants, with a total capacity of 21.4 MW, accounting for 4 per cent of the electricity generated in 2003. One other mini-hydro plant is to be established and two reactivated.

Bagasse from sugar cane, charcoal and fuel wood are important biomass fuels. Charcoal is an important source of energy in rural households. Jamaica has also been involved in experimenting with fast growing fuelwood trees. Such trees could provide one solution to problems associated with deforestation as well as provide a useful supplement to the biomass now used in the sugar industry.



Julian Herbert/Still Pictures

Approximately 600,000 tonnes of bagasse — equivalent to about 940,000 barrels of oil at a value of $37.5 million — are used per annum (as of 2003) in cogeneration in Jamaican sugar factories. Increasing sugar cane production to about 2.7 million tonnes would be needed for the supply of bioethanol. We estimate that excess electricity of approximately 300 GWh per year would be available with bagasse combustion alone, resulting in about 68 MW of available capacity.

The Scientific Research Council in Jamaica has been involved in the development of biogas plants using animal wastes in the agricultural, small manufacturing, educational and residential sectors. A total of 250 of these plants are in operation across the island, though cultural barriers are still to be broken in order to gain full acceptance of biogas as a fuel for cooking.

In addition to solar, wind and hydropower, the potential for the conversion of waste to energy, ocean thermal technologies and bio-fuels is being explored.

Sustainable future

The need for greater energy conservation is a major thrust of government policy. Incentives are being offered to encourage government agencies to reduce electricity use. A variety of conservation techniques are being encouraged in all offices, homes, businesses, and vehicles. Conservation could mean a substantial reduction in the country's fuel bill. Together with renewable energy technologies, it offers the promise of a sustainable energy future as Jamaica seeks to improve the quality of life for present citizens and future generations alike ■

P. J. Patterson is the Prime Minister of Jamaica.

From Terminator 3: Rise of the Machines

The Energy

Numbers Game

MONIQUE BARBUT describes successful attempts to build renewable energy markets and local clean energy enterprises in developing countries

When it comes to energy and development, it's easy to get lost in the numbers: millions here, billions there, and trillions into the future. Consider these four: 2 billion people without modern energy services; 500 billion dollars invested annually in energy infrastructure; and 4 billion tonnes of CO_2 dumped into the atmosphere every year from a 60 trillion dollar global economy. Taken together, they add up to a daunting challenge to the world.

Taken individually and broken down, however, they offer a different, much more immediate perspective. In Africa and India, we see houses without electricity, and smoke from fires of dung and wood. In China, we see vast tracts of slow growing forests disappearing along with the rich biodiversity that supports all life. And in New York, Paris and other developed world cities, we see refrigerators, DVDs and a range of other 'essential' conveniences.

The individual numbers are also frightening — not because they are big, but because they are so small. Less than $25 buys a better cookstove that cuts in half both the amount of fuel needed to cook and the indoor smoke and soot that kills and incapacitates women and children, causing 5 per cent of global disease.

For less than a thousand dollars — the price of a new high definition television or laptop — a family can purchase a solar home system that uses the sun's clean, renewable energy to power lights and small appliances, and allows the family to extend their children's education or generate a better income.

These sums are not beyond what most families can pay — if they can get an affordable loan. But that is a big if, because most banks consider such loans too risky — either because the technology is unfamiliar or the returns too meagre. So they charge high interest rates, pricing families out of improving their lives.

Innovative partnership

For UNEP's Energy Programme, this is the real scale of the energy challenge. Over the past six years, UNEP Energy has explored different ways to think big by acting small — small enough to make a difference for a family or village. Its projects and activities are helping to create the 'tipping points' for 'epidemics' of development, which do not have the environmental and social costs that have plagued developed economies.

The price of a tipping point may be quite cheap – as little as the one million dollars UNEP has invested in the Indian Solar Loan Programme. By creating an innovative partnership with two of India's largest banks – the Canara Bank and the Syndicate Bank — UNEP has been able to 'buy down' the cost of loans for solar home systems. Families pay a lower interest rate and banks build new loan portfolios that eventually give them the confidence — and financial returns — to lower the rate on subsequent loans.

In less than three years, the Programme has helped almost 20,000 southern Indian families to buy better energy services using clean, renewable energy. When it finished at the end of 2005, the market for solar home systems had grown and banks — including some that were not part of the original Programme — were ready to lend. UNEP has now expanded the concept to solar water heaters in the Northern Mediterranean.

Building markets

This shows the potential of building markets for cleaner energy services. Promoting new ways to finance these markets is the main focus of UNEP's Sustainable Energy Finance Initiative — or SEFI. Together with the UNEP collaborating centre, BASE – the Basel Agency for Sustainable Energy — it provides financiers with the tools, support, and global network needed to conceive and manage investments in the complex and rapidly changing marketplace for clean energy technologies.

Another successful approach is to build enterprises. Since 2001, UNEP's Rural Energy Enterprise Development Initiative — or REED — has worked with the United Nations Foundation and E+Co to develop new clean energy enterprises in five West and Southern African countries (AREED), Northeast Brazil (B-REED) and China's Yunnan Province (CREED). The programmes provide enterprise development services and early stage seed finance for promising new entrepreneurs with good business ideas to improve energy services, particularly in rural areas.

AREED is the most advanced with ▶

debt and equity investments ranging from $20,000 to $120,000 in 40 clean energy enterprises. It has helped to develop businesses in solar crop drying, sawmill waste charcoal production, efficient cook stove manufacture, wind water pumping, solar water heating, liquefied petroleum gas (LPG) distribution and energy efficiency. B-REED has invested in eight enterprises that include PV irrigation, solar drying and solar hot water, while CREED is working to address the continuing deforestation and increasing industrial waste in Western China — one of the world's biodiversity 'hotspots'.

CREED has also begun GreenVillage Credit with its partner The Nature Conservancy, providing villagers with two types of credit: one to purchase higher quality energy efficient and renewable energy systems; the other for activities that can generate income using the new and improved energy services, such as vegetable and cash-crop plantations, animal husbandry, and tourism services.

The credit is available in three villages of Northwest Yunnan and will eventually cover six villages and a total of 500-600 households. These households on average consume around 6 cubic meters of wood in fuel each year, and the project expects to reduce consumption by 15,000 to 20,000 cubic meters over the 15 to 20-year life of the installed sustainable energy system. Some households report a 30-60 per cent reduction, in turn helping to protect forest resources, better manage watersheds, and reduce greenhouse gas emissions.

For less than a thousand dollars – the price of a new high definition television or laptop – a family can purchase a solar home system that uses the sun's clean, renewable energy to power lights and small appliances, and allows the family to extend their children's education or generate a better income.

Quantum leaps

Nature often shows how to solve several problems simultaneously. UNEP similarly understands that any approach addressing a single environmental issue can be used to tackle others at the same time. Our collaborating centre, the UNEP Risoe Centre for Energy, Development and Climate, for example, is exploring the many links between outcomes that are good for development and the environment, particularly in reducing the threat of climate change.

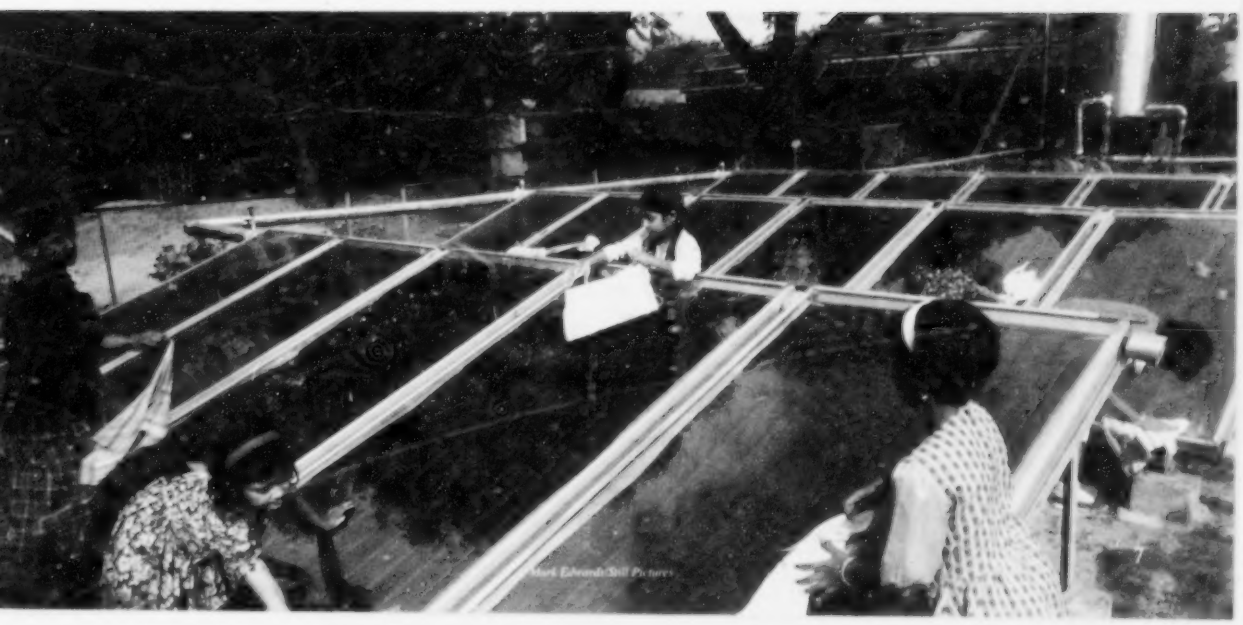
There are also many opportunities for developing countries to make "quantum leaps" to better futures, by-passing mistakes made by developed countries. The energy sector can learn from the way mobile phones have replaced fixed land lines in many developing countries as the technology of choice. They have done so — mostly without government or institutional aid — because they simply provided a superior solution to an increasing need. They also offer new services beyond telecommunications — such as transferring small amounts of money to relatives and friends via phone credits.

UNEP Energy is working through a number of international partnerships and initiatives to make cleaner energy services a similarly superior solution. With funding from the UNF and Telecom Management Partner — a subsidiary of the Norwegian multinational, Telenor — its three-year e-Commerce and Renewable Energy (eCARE) initiative in Ghana is expanding access to both clean energy and modern telecommunications services.

Working with small entrepreneurs, eCARE establishes rural business centres selling voice telephony, internet connectivity and clean energy products and services to rural and peri-urban users. These mobile, self-contained centres have both telecommunications equipment and the solar photovoltaic system to power it. They are deployed through a franchising mechanism managed by Ghana Telecom, the country's first telecommunications service provider. Each qualifying franchisee receives start-up financing combined with a package of tools, training and enterprise development services to start their rural business centers.

All UNEP Energy activities are on a modest scale, but they demonstrate the potential for rapid expansion. If we can harness the potential of a hundred REED or Indian Solar Programmes, we can truly start to make sense of the pressing numbers, the people, who yearn for the better life that sustainable development can bring ■

Monique Barbut is the Director of UNEP's Division of Technology, Industry and Economics.



Small is Powerful

AMORY B. LOVINS describes how the decentralised and efficient use of renewable energy is the key to clean development

Decentralised renewable energy is finally coming of age and is already serving tens of millions of people. In 2004 nearly 17 per cent of the world's primary energy and 19 per cent of its electricity was renewable. Most renewable energy came from noncommercial biofuels and big hydroelectric dams, but an eighth of the primary energy and a sixth of the electricity came from decentralised renewables. Two million households now have solar lighting, 16 million have biogas, and nearly 40 million have solar water heaters.

Global investment

The remarkable *Renewables 2005 Global Status Report* spells it out. Some 8.2 per cent of the world's hydroelectricity, for example, came from small hydropower (involving units up to 30 million watts, or MW) in 2004. That year China alone added nearly as much small hydro (4 billion watts, or GW) as the whole world added nuclear power (4.7 GW).

By the end of 2004, renewable 'micropower' of all kinds added up to 160 GW—4 per cent of the world's total power; some 44 per cent of this, or 70 GW, was in developing countries. These technologies received about $30 billion of global investment, much of it from private investors. This amounted to 20-25 per cent of the power sector's global total and is more than the $20-25 billion invested in big hydro—and many times the total investments in nuclear power, none of which risked private capital.

Decentralised power sources—both renewables (counting small hydro units only up to 10 MW) and low-carbon fossil-fueled combined-heat-and-power—overtook the capacity of nuclear power worldwide in 2002, and its output in 2005. In 2004, decentralised generators added 2.9 times as much output and 5.9 times as much capacity as did nuclear power; they are expected to add about 160 times as much capacity in 2010. By 2006, or soon thereafter, even the smallest and costliest renewable source—photovoltaics (PVs), which has only about 5 GW of installed capacity, but grew by 60 per cent a year between 2000 and 2004—may add more capacity than new nuclear construction.

Bioethanol and biodiesel—made at both small and industrial scale—passed 33 billion litres in 2004, equivalent to 3 per cent of the world's gasoline. In Brazil these fuels displaced 44 per cent of the country's gasoline, and now compete without subsidies: this is partly because most new cars are 'total-flex', able to burn anything from pure gasoline to pure ethanol, allowing their owners to choose rather than be captive to any specific fuel. The money saved from using less oil repaid the subsidies Brazil used to start up the biofuels more than fifty times over. Fuels made of blends of bioethanol and gasoline are legally required in Brazil, China and India, and already account for 30 per cent of the sales of gasoline in the United States.

Renewable sources

Renewable energy provided 1.7 million direct jobs in 2004, over half of them in biofuels and most of those in rural areas. At least 48 countries—14 of them developing ones—officially promote it. Europe aims to get 21 per cent of its electricity from renewable sources by 2010. China plans to obtain a tenth of its electric capacity from decentralised renewables by the same year, and will also probably install 30 GW of windpower by 2030 (industry thinks it can achieve 40 GW).

Such advances are no mere artefacts of EU and U.S. government subsidies: after all, those only amounted to $10 billion in 2004, vs. several hundred billion dollars' subsidies to fossil and nuclear energy. Indeed UNDP estimates that all renewables ▶

Renewable electric sources have a practical potential equivalent to many times today's electricity consumption

got only about 8 per cent of the energy subsidies paid out over the past three decades. Rather, decentralized renewables' rapid growth reflects steadily improving costs, technologies, markets, delivery mechanisms, and increasing official acceptance. (Citizen acceptance is seldom a problem.) Radical technological jumps will speed the shift. Clever optical concentrators that are poised to enter production can yield very cheap power from today's solar cells, and PVs that are several times more efficient still are already in the lab.

Market behaviour

Critics' claim that renewable energy is too small and slow to matter is collapsing under the evidence of actual market behaviour. So they now increasingly contend that, though necessary and desirable, renewables are limited to a minor role. Yet the Earth's surface receives solar energy amounting to 6,700 times humanity's total energy use. Renewable electric sources have a practical potential equivalent to many times today's electricity consumption. Indeed the International Energy Agency believes that they could be ripe by 2030 to produce potentially 30 trillion kilowatt-hours a year, roughly equal to total projected 2030 global electricity use.

China, the U.S. and the world could get all their power from the wind. European experience and utility studies confirm that using intermittent sources like wind and solar, even at very large scale, need not make supplies less reliable than at present if they are properly diversified, dispersed, forecasted, and integrated with the existing grid and with demand response. In fact, all power sources are intermittent: they only differ in how often and how long they are off-line and in why they fail, how predictably, and on what scale. The average U.S. nuclear plant, for example, experiences a 100 per cent shut down for an average of 36 days every 17 months, sometimes unpredictably.

Nor need land-use be a problem. Unshaded U.S. roofs could hold over 710 GW of solar cells: more could be placed on car-park shades, road verges, reservoirs, etc. All the electricity consumed in the U.S. each year could be produced from a patch of desert 160km by 160km, half-filled with inefficient solar cells, or by windfarms occupying the equivalent of a few Dakota counties.

Hidden benefits

As power markets become more transparent and competitive, they start to recognize the hidden benefits of making electrical resources the right size for their task: the book Small is Profitable identifies 207 such 'distributed benefits'. Typically these increase economic value by about tenfold—enough to tip almost any investment decision. Small, fast technologies, for example, carry less financial risk than big, slow ones; renewables bear none of the risks brought by volatility in the price of fuels; and making power at, or near, customers avoids the costs, losses and failures of electricity grids.

Integrating renewables with efficient energy use is especially lucrative because most of the energy now used is wasted. In the U.S., for example, existing technologies could save half of the country's oil use at a fifth of its price, and half of its consumption of natural gas at a sixteenth of its price. Similarly, they could cut its electricity use by three-quarters at less than the cost of running, and delivering the power from, a free nuclear or coal plant. The potential percentage savings are somewhat smaller, and more costly, in the most energy-efficient countries—but far bigger and cheaper in developing ones. For every dollar of GDP (at

purchasing power parity), China uses about nine times as much energy as Japan, five times as much as Europe, and three times as much as America, so energy efficiency is now its top development priority; and even Japan has great efficiency potential still uncaptured.

Energy efficiency

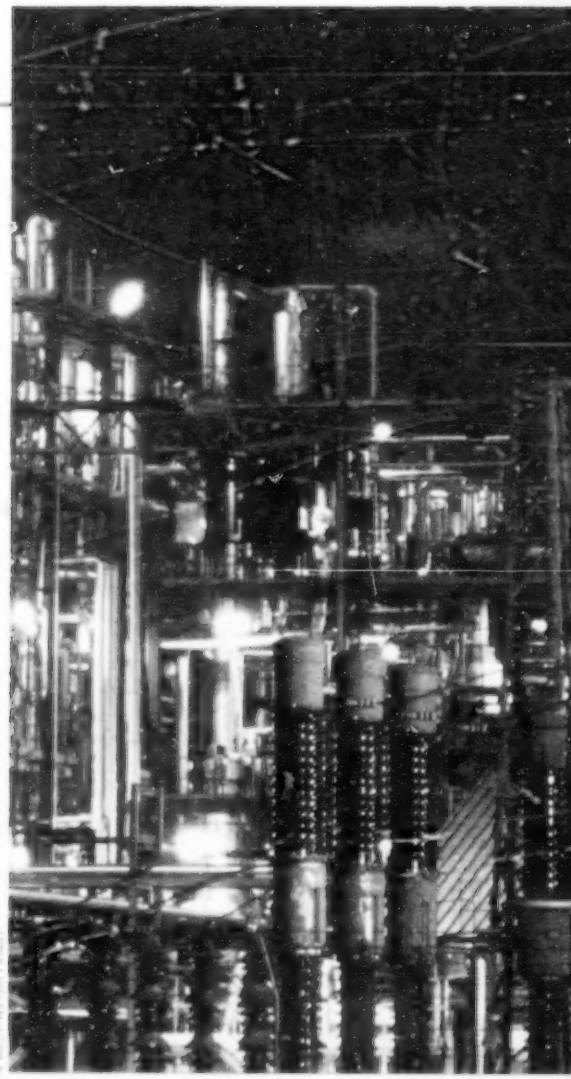
Since achieving efficient use costs less than the fuel and electricity saved, the problem of climate change can be solved at a profit, rather than at a cost. And since making electricity-saving technologies needs about 10,000 times less capital than generating more electricity, the power sector—now a black hole for a quarter of the world's development capital—could become a net exporter of capital to meet other development needs.

Energy efficiency can greatly expand and speed renewable supplies by making them smaller, simpler, cheaper, and more effective:

- A house that saves hot water can get most of its water-heating from solar energy using only a small collector with little or no backup. My home, high in the Rocky Mountains, which experiences up to 39 days of continuous midwinter cloud, gets 99 per cent of its hot water from the sun, with the help of a stratified five-cubic-metre storage tank.
- A house that enjoys all modern conveniences, but uses electricity with elegant frugality, can get all its power from only one to two square metres of PVs. Those and the associated equipment can cost less than just connecting to the grid a few meters away.
- A building lit by daylight, and heated by passive solar energy, needs little electricity, and can pay even for costly forms of onsite generation, such as PVs, with money saved by reducing the size of heating and cooling systems. Those systems have been eliminated altogether, with better comfort and lower construction cost, at temperatures from - 44 to + 46°C.
- The Santa Rita Jail in Alameda County, California, installed efficiency and load management measures before adding 1.18 MW of PVs to its roof. As a result it needed less power at peak-load periods, and could sell more back to the grid at the best price, gaining benefits 1.7 worth times the unsubsidised costs.

Beyond oil

The U.S. could eliminate its use of oil over the next few decades—and that transition could be led, for profit, by business. Half of U.S. oil consumption could be saved through efficiency, including cars, trucks, and planes three times as efficient as now. The rest could then be replaced by advanced biofuels, which need no cropland, and saved natural gas. Such



an oil-free America would save $70 billion a year, even with oil at the low price of $26 a barrel. Other countries could do much the same. Indeed some, like China, may well leapfrog the West to help lead the world beyond oil.

Problems like climate change and oil dependence are therefore artefacts of unnecessarily using or supplying energy in a way that wastes money. If we simply buy the cheapest energy options first, most energy-related problems will fade away, leaving a healthier, fairer and safer world. ■

Amory Lovins, a physicist, is co-founder and CEO of the Rocky Mountain Institute.

Additional Resources:

Rocky Mountain Institute
http://www.rmi.org

Renewables 2005 Global Status Report
http://www.ren21.net

Small is Profitable
http://www.smallisprofitable.org

Winning the Oil Endgame
http://www.oilendgame.com

PEOPLE

Kofi Annan, the United Nations Secretary-General, has been awarded the 2005 Zayed Prize for Global Leadership for the Environment for "catalyzing political and public opinion to an understanding that the environment is a fundamental pillar of sustainable development."

This is one of three Zayed awards, which together make up the Zayed International Prize for the Environment, the world's largest and most valuable environmental prize, worth a total of $1 million.

UNEP

Kofi Annan

The award for Scientific and/or Technical Achievement in Environment was won by the **1,360 experts of the Millennium Ecosystem Assessment**, which has catalogued the condition of the globe's ecosystems and their life-giving services. And the award for Environmental Action Leading to Positive Change in Society has been shared between **Angela Cropper,** co-President of the Cropper Foundation of Trinidad and Tobago and **Emil Salim**, former Indonesian State Minister for Population and the Environment.

The Prize was established by **Sheikh Mohammad Bin Rashid Al Maktoum**, Crown Prince of Dubai and United Arab Emirates Minister of Defense, to acknowledge the environmental commitment of the late **Sheikh Zayed Bin Sultan Al Nahyan**. Previous winners of the Global Leadership award, which is worth $500,000, have been **Jimmy Carter**, the former President of the United States, and the **British Broadcasting Corporation**.

UNEP

Emil Salim

The International Jury, chaired by **Klaus Toepfer**, UNEP's Executive Director, said that "Mr Annan has emphasised the importance of the multilateral system in all facets of his work, convinced that global environmental challenges require global cooperation". It noted his personal leadership at the 2002 World Summit on Sustainable Development in Johannesburg, and reports that he requested in the run up to last year's World Summit in New York.

And it added: "Five years ago, recognizing the potential threat that environmental degradation posed for people around the world, Mr Annan also called for the first-ever international scientific assessment of the health of the world's ecosystems."

It is the 1,360 experts from 95 countries who contributed to this Millennium Ecosystem Assessment who win the $300,000 second category award. The jury called it a "landmark study on the condition of the world's ecosystem services from fisheries and freshwaters up to the carbon capture of the world's forests."

It added that the Assessment "also underlines the economic importance of natural or nature's capital and demonstrates that the degradation of ecosystems is progressing at an alarming and unsustainable rate".

The Jury describes the Assessment as a remarkable scientific achievement which is "commanding political attention while shaping the environmental agenda of the 21st century, especially in the challenging area of ensuring nature's capital is given real value alongside financial and human capital."

Cropper Foundation

Angela Cropper

Ms Cropper, who shares the $200,000 third category award with Mr Salim, is a co-chair of the Assessment Panel of the Millennium Ecosystem Assessment. Mr Salim is the chair of the board of trustees for numerous Indonesian environmental organisations.

Dr Mohamed A. Bin Fahad, Chairman of the Zayed Prize Higher Committee, said that the secretariat had received over 80 nominations for the awards from all five continents. He added that the Committee hoped that the Millennium Ecosystem Assessment would use the Award money to disseminate its achievements and make them available to all world communities and policy makers.

Klaus Toepfer said: "The Jury was faced with many outstanding candidates for the Zayed Prizes. But when you look at the overall global impact on politics, business, science and civil society of Mr Annan's environment and sustainable development related initiatives, we came to the conclusion he is deservedly the global winner."

He added that the winners of the other two categories "are also outstanding in their own right" and looked forward to welcoming them to the award ceremony in Dubai on 6 February ■

Obituary

The United Nations Environment Programme was profoundly saddened by the sudden death in January 2006 of

His Highness **Sheikh Maktoum Bin Rashid Al-Maktoum,** Vice-President and Prime Minister of the United Arab Emirates and Ruler of Dubai. Executive Director, Klaus Toepfer, expressed his heartfelt condolences to His Highness's family and to the leadership and people of the United Arab Emirates. The international community has lost a great leader and an ardent supporter of sustainable development.

Ultimate

Energy

TAKASHI TOMITA says that solar power is needed to improve people's lives, protect the environment and enhance world peace

Global mean temperature has been increasing at a rate of about 0.74 degrees a century and its rate is accelerating, while the sea level has risen by 10 to 20 cm over the past 100 years. Ten typhoons landed on Japan in 2004, the most ever — while catastrophic hurricanes hit the south-east United States, causing huge damage in 2005.

Human activities, as well as natural phenomena, cause such climate anomalies. The accumulation of greenhouse gases since the Industrial Revolution — emitted by such human activities as the massive consumption of fossil fuels — is one of the causes of global warming, which is gradually leading to an unbalanced environment around the globe. The Kyoto Protocol was agreed in 1997 as one countermeasure and came into effect in 2005. It is time to improve our energy use and restructure our energy consumption patterns.

Ultimate energy

Oil, coal, hydropower, wind energy, biomass, and solar energy are all directly or indirectly derived from the sun. Solar energy is the ultimate energy source and the time to establish the basis for a future society based on it is imminent.

Solar power generation systems convert sunlight directly into electricity, through so called solar cells. About 1,200MW of the cells were produced outside in 2004, while the cumulative amount of installed solar power generation systems across the globe reached 2,600MW that year. The cells do not emit any gases or noise and can replace fossil fuels. They are being established and becoming important in Japan, Europe, the United States and other parts of world thanks to incentive programmes.

Every year each square metre (150W) of solar cells installed in Japan, in the planet's middle latitudes, generates 158 kilowatt hours of electricity, saves the equivalent of 39 litres of oil, and cuts the world's burden of carbon dioxide by as much as 316 square metres of forest.

The most beneficial feature of solar power generation can be summed up as: "wherever sunlight is, electricity can be generated". It enables people to be blessed with electricity — enjoying lighting, watching TV, listening to the radio, and even accessing the internet — even when the grid is far away. This in turn can be cleverly used:

- to produce water: Solar power can make it easier to supply drinking water, by pumping it up from wells, desalinating seawater and purifying waste.
- to provide food: It can help supply water for irrigation, thus increasing food production from crops and livestock.
- to maintain good health: It can help store medical supplies and keep a sanitary environment, which is particularly important for reducing infant mortality.
- to build global peace: As it helps provide access to information, water and food, the world will experience fewer conflicts and wars.

Increased awareness

The Sharp Corporation, which was founded in 1912, began developing systems for generating solar power as long ago as 1959. Its business field is now very broad, ranging from home appliances to electrical components including Liquid Crystal Displays.

As protecting the global environment has become an important issue, and as awareness continues to increase, Sharp has set a medium-term goal of becoming an environmentally advanced company, focused on making products that contribute to environmental protection and healthy living.

In 2004, it defined its corporate vision as being a company that has "Zero Global Warming Impact by 2010". Its action plan aims

- to limit greenhouse gas emissions from its business activities around the world to the greatest extent possible.
- to reduce emissions significantly on a global basis through providing solar cells and energy efficient new products to our customers around the world.
- to achieve a net effect of cutting greenhouses gas emissions by the fiscal year 2010, by ensuring that the reductions in them achieved by using our products are greater than the amount of them emitted by our business.

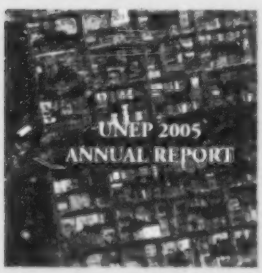
The world's energy system must be revolutionised for a future sustainable society. Currently heavily dependent on fossil fuels, it should gradually evolve to a new one where renewable energy — including solar energy — plays an important role across the globe.

Global environmental protection has become a common cause for all people around the world. Generating solar power can not only improve people's lives but can increase the environmental protection of the earth, enhance world peace and ensure the continued existence of all humanity ■

Takashi Tomita is Corporate Director and Group General Manager of Solar Systems Group, SHARP Corporation.

BOOKS & PRODUCTS

More than 140 experts have been involved in preparing UNEP's newly published ***GEO Yearbook, 2006: An Overview of Our Changing Environment***. Its Feature Focus elaborates on the environmental, socio-economic and public health impacts of energy-related air pollution. Its chapter on Emerging Challenges identifies environmental effects and best practices related to fish and shellfish farming in marine ecosystems. And the GEO Indicators show that rising greenhouse gas emissions are resulting in ecosystem changes, and that increasingly intense exploitation of fisheries stocks is leading to serious depletion: but they also give ground for hope that action can bring positive results, as in the continuing decrease in consumption of chlorofluorocarbons, and the increasing proportion of the Earth's surface affording some form of environmental protection to biodiversity.



The ***UNEP 2005 Annual Report*** looks at the organ-ization's work and ac-hievements during the year. Under the headings 'Environment for a Secure Future' and 'Protecting Nature s Capital' it gives an overview of UNEP's contribution to sustainable development in a year in which world leaders reaffirmed the centrality of environment for development and the Millennium Ecosystem Assessment revealed the extent of global environmental decline. It is available from *www.earthprint.com*.

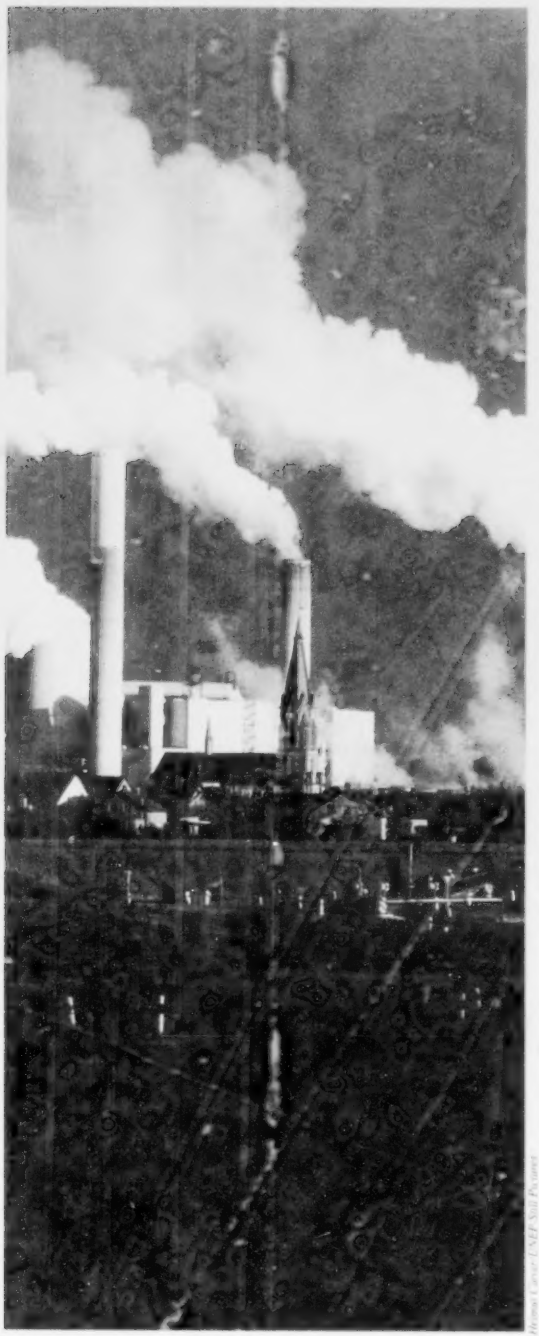
The North-eastern Indian state of Assam is planning to establish **two one megawatt power stations** that run on **bamboo**. The giant grass – 80 million tons of which is grown in India each year – will first be turned into gas, and then used to generate electricity, in a process developed at the **Indian Institute of Science** in Bangalore. The $2.2 million plants will initially provide power for local paper mills, but Vinay S. Oberoi, director of the **National Mission on Bamboo Applications**, says the technology could be widely used, including in "off-grid and remote locations." He adds: "We are confident the commercial success of gasification of bamboo for generation of electricity would help us solve the energy crisis facing India."

New York is building a fleet of 825 **hybrid buses**, in a move that will reduce pollution and save fuel in the city: 325 of the $500,000 **Orion VII** buses, made by **Daimler Chrysler** have recently been delivered, with a further 500 due by the end of next year. Each bus has a diesel engine optimized to run at near-constant speed, which feeds power to an array of 46 batteries on its roof, which in turn provide it with an extra boost for quick starts and hill climbs. Each one will save some 5,000 gallons of diesel a year, and when all are in service they will have the same effect as replacing 15,000 cars on the streets of the Big Apple with **Toyota Priuses**.

The first-ever synthesis of the status of renewable energy worldwide has been released by the **REN21 Renewable Energy Policy Network**, formed as a result of the Bonn Renewables 2004 Conference. The ***Renewables 2005 Global Status Report*** draws on some 250 published reference sources and has involved more than 100 researchers and contributors from at least 20 countries. Produced by the **Worldwatch Institute**, it provides an assessment of several renewable technologies — small hydro, modern biomass, wind, solar, geothermal, and biofuels — that are now competing with conventional fuels in power generation, hot water and space heating, transport fuels, and rural (off-grid) energy supplies.

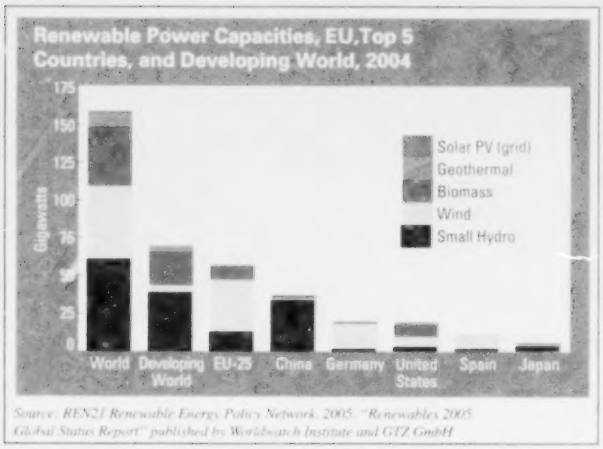
A new UNEP publication, ***The Hydrogen Economy***, summarises in non-technical language the central issues and challenges in moving to a hydrogen-based energy economy — increasingly believed to be the future by policy-makers, environmental organizations, energy analysts and industry leaders — and assesses what the process might mean for the environment and policy-making. Produced by the **Energy Branch** of UNEP's **Division of Technology, Industry and Economics**, it is intended to support the discussions on energy at the **2006 Global Ministerial Environment Forum** meeting.

AT A GLANCE: Renewables



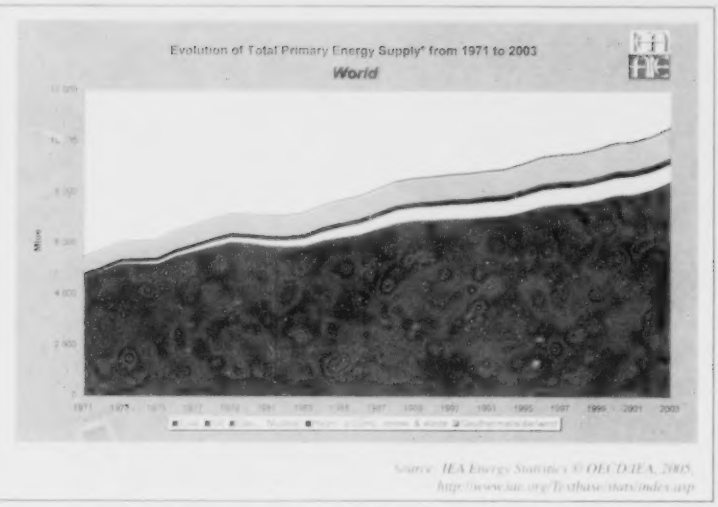
Renewable energy is fast becoming big business. The International Energy Agency forecasts that it will receive one third of all new investment in electric power generation in OECD countries over the next thirty years. Developing countries already have almost half of the world's 160 gigawatts of installed renewable power capacity and nations like Brazil, China and India are leaders in developing the technologies.

There are more than 4.5 million consumers of electricity from renewable sources in Europe, Japan and North America, says the Renewables 2005 Global Status Report. Over 40 million homes worldwide — more than half of them in China — get hot water from rooftop solar collectors. And 16 million families in developing countries cook their food and light their dwellings with biogas.



Source: REN21 Renewable Energy Policy Network. 2005. "Renewables 2005 Global Status Report" published by Worldwatch Institute and GTZ GmbH

Large commercial banks — such as Citigroup, ANZ Bank and the Royal Bank of Canada — are financing it as a mainstream activity. Morgan Stanley is investing in windpower in Spain. Goldman Sachs has bought a US wind development company. Venture capital in US-based clean energy technology companies is approaching $1 billion a year. The European Investment Bank provided over $1.8 billion for renewables between 2002 and 2004, and is planning to double these sources' share of loans to energy projects.



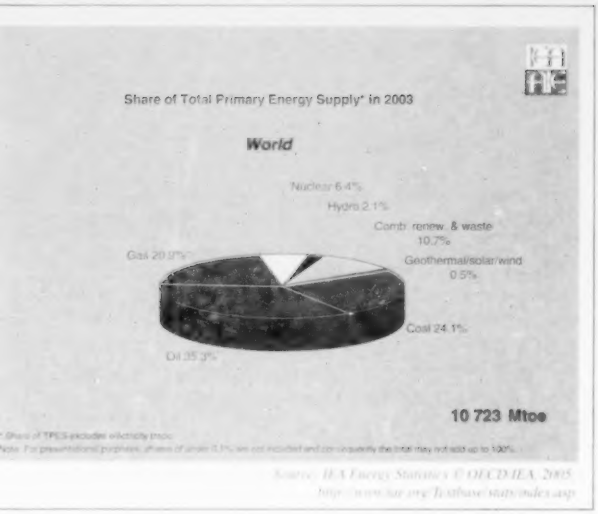
Source: IEA Energy Statistics © OECD/IEA, 2005, http://www.iea.org/Textbase/stats/index.asp

Solar photovoltaics is becoming one of the world's most profitable, and fastest growing industries: its capacity connected to the grid grew from 0.16 GW at the turn of the millennium to 1.8 GW by the end of 2004 — an average annual growth rate of 60 per cent – and it covers 400,000 roofs in Japan, Germany and the United States.

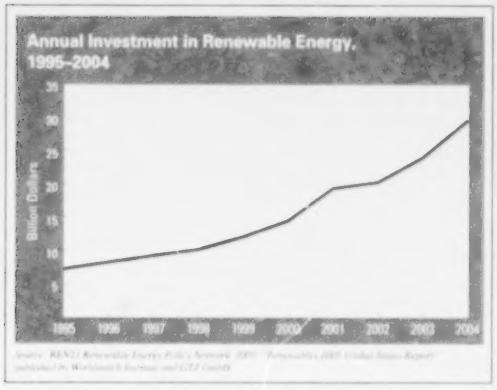
Over the same period windpower grew by an average 29 per cent a year, biodiesel by an average 25 per cent and solar hot water and heating by an average 17 per cent. These compare with averages of 3 to 4 per cent annual increase in the capacity of fossil fuel power stations and of 1.6 per cent for nuclear ones.

The Solar and Wind Energy Resource Assessment, coordinated by UNEP, has found that windpower development would be possible on about 13 per cent of the land area of developing countries it surveyed, a vast increase on the one per cent previously estimated; in Sri Lanka, for example, it could provide more than ten times the country's existing electric power capacity. And Brazil has led the world in the use of modern biomass, with energy from sugar cane now meeting 13 per cent of the country's total requirements, including supplying 40 per cent of its gasoline.

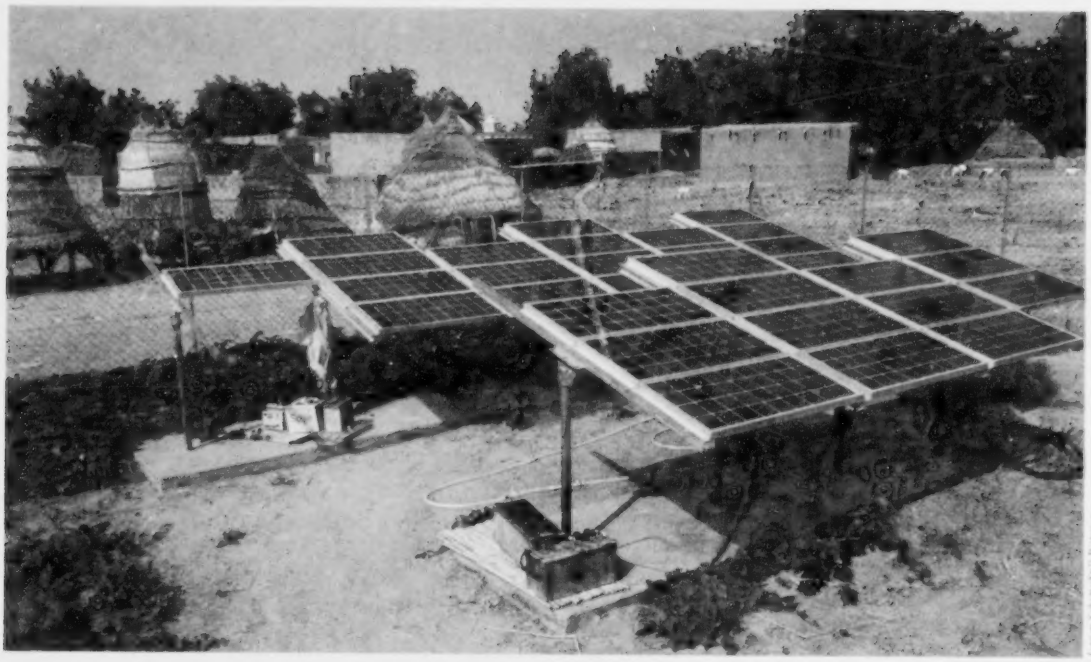
Meanwhile financial flows to new renewables in developing countries are running at almost $500 million a year — mostly from the German Development Finance Group, the World Bank and the Global Environment Facility; in 2004 the World Bank committed to double its finance for them and energy efficiency within five years. And the Indian Renewable Energy Development Agency has provided almost $1.5 billion over the last two decades.



Source: IEA Energy Statistics © OECD/IEA, 2005, http://www.iea.org/Textbase/stats/index.asp



At least 43 countries have national targets for renewable energy supply. But all of this is still just a beginning and needs to be vastly expanded. For no other energy sources offer such potential for simultaneously combating both poverty and climate change — the two greatest issues of our time. GL



Jürgen Schreiber/Still Pictures

Prima Donna *Power*

HERMANN SCHEER describes how photovoltaic solar energy conversion offers humanity a unique opportunity and calls for political programmes to promote it

Photovoltaic energy (PV) is the primadonna of renewable energy technology. Currently, it generates just a small part of total renewable energy supply, less than wind, hydro power or biomass. But it also bears by far the biggest potential — larger than that of all other renewable energy sources, larger than anything to which fossil fuels and nuclear power could ever aspire. Photovoltaics are the most promising of all energy technologies, giving us the best option to overcome global energy crises.

Energy potentials

The global primary energy potential of fossil fuels and uranium is concentrated at a few geographically limited sites, so they need long supply chains to most of their consumers, which in turn causes high transmission and distribution costs and important losses of energy. The primary energy potentials of hydro power, windpower and biomass may be spread much more widely, but their technical and economic usability is still limited by topographic constraints and depends, for example, on good regional wind speeds and soil quality.

Solar energy radiation is the only primary source directly exploitable at every place on earth. It therefore offers everyone free access to energy and, moreover, to electricity, that most modern and multifaceted form of energy services. Thus PV facilitates energy freedom for everybody — free from discrimination, artificial national borders and administrative hurdles, and free from dependency on energy monopolies.

Unique flexibility

Moreover, PV technology makes modular electricity production possible. Every single PV module can work independently, whether it measures 5 square centimetres or 5 square metres, giving the technology unique flexibility.

Its wide range of applications varies from solar modules in calculators, cellular phones, power books and ventilators, and installations on roofs and façades to PV power plants made up of millions of modules, which can be constructed in arid and semi-arid regions. Installations can follow demand, on a 'just in time' basis — thus avoiding misdirected investment — as upgrading with additional modules is always possible. Installation can be carried out exactly where the electricity is needed, avoiding the construction of a costly transmission ▶

network. It can therefore provide electricity immediately to two billion people without any connection to the power grid.

Even more importantly, PV modules can be installed within a few hours, big PV power plants in just weeks — in contrast to the several years of construction required by fossil fuel or nuclear power plants. This makes photovoltaics particularly attractive in areas of the world where rapidly increasing energy demand has to be met.

Avoiding expenses

PV — like windpower— consumes not a single drop of water, in contrast to the immense amounts used by fossil fuel and nuclear power plants. This gives it a further advantage, especially when consumption for conventional energy supply competes with a direct demand for water by people and agriculture.

It also makes entirely decentralised energy independence possible. The opportunities for PV applications broaden as decentralised electricity storage develops — through lightweight electrochemical batteries which have no environmental impact and do not need many charge cycles; through electrostatic storage with super capacitors; through electromechanical options like fly-wheels and compressed air, or electrodynamic ones like superconducting magnets; and through using hydrogen or thermochemical methods.

Cost dynamics also favour PV. Its economic rationale lies in avoiding expenses — like fuel, grid and external environmental costs — that are inevitable in conventional electricity production. Its cost is constantly decreasing through economies of scale and technological improvements while conventional energy is experiencing equally constant increases in fuel and grid costs, as well as in water consumption and environmental damage.

Political instruments

Just one question remains: How can mass production of PV be initiated and how can investments in the technology be financed. These are one-time investments; the only running costs are for maintenance. They require long-term loans, especially where micro-credit is needed.

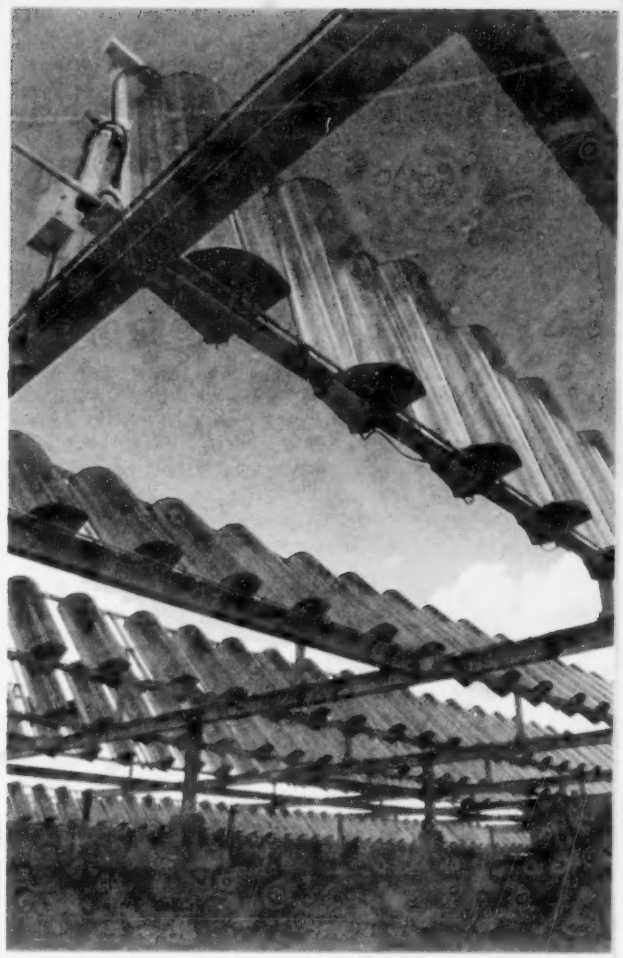
If it is to take off, PV needs political promotion schemes, which transform its advantages for national and environmental economics into incentives for individual investment. A variety of political instruments already exist — from loans at low and zero interest rates to legally fixed feed-in tariffs such as provided under the German Renewable Energy Act.

Accelerating the development of renewable energy will cost much less and have long term economic, ecological and social benefits

Such political initiatives are justified, both because nuclear power has received about $1 trillion in subsidies over the last 50 years, and because direct and indirect subsidies for fossil fuels add up to around $500 billion. Accelerating the development of renewable energy will cost much less and have long term economic, ecological and social benefits. It will, for example, help prevent further international conflicts over energy resources. And photovoltaic solar energy conversion can create good lives with access to modern communication in the developing world's villages, thus preventing hundreds of millions of people migrating into the ever increasing slums. And meanwhile a new solar architecture can clean up the cities of the industrialised world.

Thus political schemes for promoting photovoltaics will guarantee a cheap, ecological and secure future energy supply for everybody ■

Dr Hermann Scheer is President of EUROSOLAR and General Chairman of the World Council for Renewable Energy (WCRE).



Falling Water

Rising Power

RICHARD TAYLOR says that sustainable hydropower, although not a panacea, is infinitely renewable, improves energy security and reduces poverty – yet has still to realise its full potential

Hydropower produces almost a fifth of the world's electricity and supplies 92 per cent of electricity derived from renewable sources, yet only a third of the world's potential resources have so far been developed. This is particularly surprising as there is great scope for it in countries where the need for electric power is greatest.

Sustainable hydropower is a renewable, safe, clean, and reliable source of energy. It already supplies energy to 161 countries, and its development is most advanced in some of the richest and most environmentally aware nations.

It can become one of the international community's key tools in the struggle to raise the living standards of the poorest. No society has ever successfully tackled poverty without addressing water and energy security and the supply of affordable and reliable water and electricity can make a major contribution to meeting the Millennium Development Goals.

Infinitely renewable

Based on the simplest of principles, hydropower uses gravity to produce electrical power. As water is released through the turbines, generating power, the force is, in essence, free and infinitely renewable. Water is not consumed in the process. It passes through the power plant unchanged and can be returned to the natural river course and/or used for irrigation, water supply, and fisheries – and to help improve navigation.

It enables power to be stored effectively in freshwater reservoirs, allowing it to be released to meet sudden peaks in demand or loss in supply from other sources. This makes it the natural renewable partner for other technologies – such as wind, wave, tidal or solar energy – which do not themselves provide a continuous supply.

Energy security

It also improves energy security. As long as seasonal water flows are stored sensibly, hydro generation is entirely predictable. It is immune to fuel price fluctuations, and already offsets the need to burn 4.4 million barrels of oil equivalent worldwide each day. In a mixed energy system, hydropower's flexibility also enables fossil-fuel plants to operate in a steady state at their highest efficiency, further reducing emissions.

Recent events have brought power generation and its impact on our lives into sharp focus, and greatly increased the recognition of how energy policies affect our planet's well-being. Despite best efforts to manage it, global demand for electricity is expected to double in the coming decades.

Fossil fuels are causing economic and political conflict. And, alarmingly, there are increasing differences of opinion around the world between those that have abundant domestic sources of them and those that do not. But we must, of course, acknowledge that these fuels are

Sustainable hydropower is a renewable, safe, clean, and reliable source of energy. It already supplies energy to 161 countries, and its development is most advanced in some of the richest and most environmentally aware nations.

an integral part of contemporary life — and make the best use of them during our transition to a cleaner energy future.

Clearly there is a need to make the best use of all technologies, including hydropower whose capacity could be tripled by judicious investment. At present, its usage varies hugely. Europe makes use of three-quarters of its hydropower potential, Asia less than a quarter. And in Africa, only 7 per cent of the hydropower potential has been exploited although tens of millions of people live without electricity.

Yet — while communities that have already developed hydropower enjoy cheap and reliable power — the costs of implementing new projects are onerous. High planning and construction costs create a financing challenge — though the subsequent running costs come in at just a tiny fraction of them. Innovative, longer-term financing and cleaner-energy credit will be required to transcend the financial barriers and exploit the economic and sustainable benefits of hydropower in the developing world. This is an ambition worth achieving, and the hydro sector is seeking to work with all stakeholders to find appropriate solutions.

Sustainable practices

The International Hydropower Association's biennial Blue Planet Prize recognises excellence in sustainable practices at hydropower facilities. One of this year's winners, the Andhikhola Hydel and Rural Electrification Project in Nepal, won for excellence in socio-economic benefits and capacity building. Described as 'inspirational' by the inspection team, it delivers reliable water and electricity to 100,000 local people in rural Nepal, making electricity affordable for the first time to 22,000 low income families. It has also enabled local cooperatives to establish irrigation systems, which have stabilised food security in the region.

Voluntary standards

Blue Planet Prize nominations are evaluated in accordance with the Association's Sustainability Guidelines and Compliance Protocol — recently acknowledged by the Organization for Economic Cooperation and Development — which are designed to promote greater consideration of environmental, social and economic aspects in assessing the sustainability of new projects and managing existing schemes. The hydropower sector continues to make progress with these voluntary standards in planning, constructing and managing schemes with sensitivity to local communities and the environment. The future challenge is to ensure that all actors in the sector realise their full potential to help meet the world's growing needs and to lift communities out of poverty, by delivering sustainable water and energy security.

Environmental goals

In the words of Stéphane Dion, Canada's Minister of the Environment and President of the United Nations Climate Change Conference in Montreal in December 2005: "There is no doubt that hydropower can play a significant role in meeting many environmental goals, including climate change. In our increasingly carbon-constrained world, renewable energy forms, such as hydropower, have the potential to meet the sustainability criteria demanded of our times." ■

Richard Taylor is Executive Director of the International Hydropower Association.

Waking the Giant

ELENA MERLE-BÉRAL describes how the world's largest energy nation would benefit from developing renewable sources of energy, despite its wealth of fossil fuels

Russia is a renewable energy sleeping giant. It has huge potential—biomass, hydro, wind, geothermal, solar and tidal—but this is hardly developed. Why? Many believe that only energy-dependent countries need to develop renewable energy, while Russia, as the world's largest producer and exporter of fossil fuels, does not require this 'expensive toy'. Yet it can play a role even in the Russian energy mix.

Russian experts estimate the country's economic renewable energy potential may correspond to about 30 per cent of its actual total primary energy supply (TPES). One study assesses renewables' economic potential at more than 189 million tonnes of oil equivalent (Mtoe) a year compared to 640 Mtoe of TPES in 2003. Yet current use is insignificant. Renewable energy (excluding hydro) and waste account for only 1 per cent of Russian TPES —increasing to 3 - 3.5 per cent when large hydro is taken into account.

The accuracy of these estimates can be questioned, but it remains clear that the diversity of Russia's geology, climate and terrain has endowed it with significant and various renewable energy resources — and that it has the scientific and technical base to develop them.

Modern technologies

Research and development on renewables started in the Soviet Union in the 1920s, and since then Russia and other former Soviet states have developed nearly all the currently known renewable energy technologies. Their cost is lower than in western countries — and so, typically, is their quality and reliability. Following the decline in industrial production of the 1990s, many idle plants and factories, especially in the military complex, converted to producing more modern technologies, including renewable energy systems. But, lacking ready markets, a commercial industry has been slow to develop.

Why should Russia care about renewables while it has abundant oil, gas and coal reserves? There are many applications — including heating and both large-scale and decentralised electricity generation — where they may have a competitive advantage over conventional energy sources. There will be more such applications in future as domestic gas

prices increase and the cost of renewable energy technologies falls further.

Although Russia as a whole exports energy, most of its regions import fossil fuels from a few energy-rich ones, especially Western Siberia. Transporting fuel over the vast distances between regions dramatically increases its total cost: indeed, some remote territories — such as Kamchatka, Tyva and Altai — spend more than half of their budgets on energy. Supplies, moreover, are disrupted quite frequently.

Most regions, however, have locally-available renewable energy resources that can be exploited to improve energy security and reduce costs. Geothermal plants are viable in Kamchatka, the Kuril Islands and the North Caucasus. Large-scale use of biomass energy is cost-effective in north-western Russia, which has a well-developed pulp and paper industry. Wind projects can eventually become commercially attractive in far eastern coastal areas, in the steppes along the Volga River and in the North Caucasus. Many regions enjoy favourable conditions for small-scale hydro-electric power.

Potential market

There is an enormous potential market for off-grid renewable energy systems. About 10 million Russian people are not connected to an electricity grid, and are served by stand-alone generating systems burning petrol or diesel fuel. Remote northern and far eastern areas get their fuel by rail or road, sometimes even by helicopter. The cost of transport is not entirely borne by the users of these systems, and removing subsidies would make renewable energy a viable alternative. The Russian 'dachas' or country houses provide another potential market. Nearly all Russian families have a country house, or a small plot of land where they grow vegetables and fruit: many of these dachas are not connected to a grid, many others have only an unreliable power supply.

Using renewables for heating can be particularly attractive in Russia's cold climate. Directly using geothermal energy for space heating and hot water is commercially viable in Kamchatka and other regions with geothermal resources. Converting coal- or oil-fired district heating boilers to burn biomass (especially wood waste) is also cost-effective, particularly where consumers face unsubsidized heavy fuel oil and coal prices. Small and medium-sized boilers have already been converted in this way Belarus, Estonia, Latvia, Lithuania, and some Russian regions.

Efficient policies

Renewable energy can contribute to regional economic development, create local jobs, and cut air pollution and greenhouse gas emissions. Increasing domestic use of renewables would free more oil and gas for export. This could be particularly important as the oil and gas sectors face significant investment challenges to meet both domestic and export demand: IEA estimates suggest that they will need to invest $24 billion per year, on average, until 2030.

The IEA projects that Russia's total primary energy demand will grow at an average rate of 1.3 per cent per year from 2002 to 2030, on a business-as-usual scenario, reaching 885 Mtoe in 2030. Renewable energy use will meanwhile grow more than twice as fast, at 2.7 per cent; yet it will account for only 15 Mtoe or 2 per cent of primary energy demand in 2030, not including hydro – which will supply another 17 Mtoe. But prospects will be brighter if the government adopts efficient policies and measures to ensure a level playing field for different energy sources.

The current structures of the energy market and domestic energy prices are major barriers to increasing the use of renewables. Russia's energy mix is dominated by natural gas, accounting for 54 per cent of TPES, and 43 per cent of electricity generation. Domestic gas prices are state-controlled and are often kept below cost, as are electricity and heat tariffs. Cross-subsidies are still widespread. So it is not surprising that renewable energy is often not competitive compared with the distorted prices of conventional energy.

Nevertheless, Russia is making important progress in moving toward market-based pricing. Domestic gas prices are gradually rising, opening new opportunities for renewables. An ambitious programme of electricity sector reform reflects recognition among policymakers that it is vital to create markets that operate in response to genuine price signals. The key is how the programme will be implemented. Reform of the district heating sector, however, is less advanced.

Improving the overall investment climate, by continuing economic, financial, legal, regulatory, and fiscal reforms, is essential both for renewables and for the energy sector as a whole. If Russia maintains and extends the reforms – and eliminates subsidies for conventional energy sources – the giant will begin to wake ■

Elena Merle-Béral is an analyst in the International Energy Agency and co-author of Renewables in Russia: from Opportunity to Reality *and* Coming in from the Cold: Improving District Heating Policy in Transition Economies.

Blowing in the **Wind**

KALPANA SHARMA describes how a developing country has become the world's fourth largest generator of wind power

India's rapid economic growth rate, now eight per cent a year, threatens to slow down if it fails to find dependable and sustainable sources of energy. At present it imports most of its oil, and generates over half its electricity from coal-powered thermal stations.

Yet, electricity is in short supply all over the country, and the energy shortfall affects business and industry. Maharashtra, India's most industrialised state, faces a deficit of up to 4,000 MW, forcing power cuts ranging from four to eight hours a day. The impact on development in India's villages, where most of its people continue to live, is far more serious still. Lack of dependable power affects health and the ability of the poor to pull themselves out of poverty.

Little hope

On paper, 80 per cent of India's villages — and 44 per cent of rural households — get electricity. In fact, most of them receive it for only a few hours in a day. This means water cannot be pumped for drinking and agriculture, homes have no lighting after dark, children cannot study beyond daylight hours and health centres cannot maintain stocks of medicine that require refrigeration. Women carry the double burden of collecting water and fuel for cooking, and this is in no way lightened by the absence of electricity.

Without electricity, there is also little hope of villages moving beyond primary agricultural production to adding value through food processing or other industries. Thus, the absence of electricity ensures that villages remain deprived of the fruits of the economic growth so evident in urban India.

Vast potential

Alternative energy sources have long been mooted as the answer for some of these problems. But despite having a Department for Non-conventional Energy Sources in the central government, only 5 per cent of India's energy comes from renewables (though their 6,158 MW capacity is still almost

double nuclear power's 3,310 MW). Solar energy, for instance, remains hugely underutilised despite its vast potential in a country where many areas get sunshine for most of the year.

Yet India's wind energy has grown dramatically since its first wind farm was set up in Mandvi in the state of Gujarat in 1986 with a capacity of just 55 MW. It has now just surpassed Denmark, one of the pioneers of the technology, and provides sixty per cent of the electricity the country derives from renewables. Germany is the leading windpower nation with 18,000 MW of the world's 48,000 MW installed capacity. Spain and the United States are second and third. The European Wind Energy Association believes that wind power has the potential to meet 12 per cent of the world's electricity requirements.

Dr. Anil Kane, Chairman of the Indian Wind Energy Association says that this is one of the fastest growing sectors in the country. At the rate at which new wind energy farms are being set up in India, he says, its capacity from the wind will exceed 5,000 MW in less than two years , up from the present 3,595 MW.

Energy farms

More than three fifths of India's windpower are generated in the southern state of Tamil Nadu, which has a double advantage, getting winds from the South West and the North East. As a result, a 1 MW machine there can generate 3.5 million units a year as compared to 2 million units in a western state like Maharashtra.

The initial start-up costs of wind energy are expensive, working out to Rs. 45 to 50 million per MW (just over $ 1 million), but since over 90 per cent of the cost of wind generation is in servicing its financing, these costs can be recovered in 10 years. Over the next decade the only costs are operational and maintenance ones, and so the cost of the energy is reduced to a mere 40 paise (approximately 9 cents) per unit.

The Centre for Wind Energy Technology estimates that the potential for wind energy in India is about 45,000 MW, a figure arrived at after one of the largest mapping programmes in the world where five to six hundred meteorological masts were set up around India. But even though this is more than ten times present capacity, the Indian Wind Energy Association estimates that the potential from wind energy in India is more than twice that, at least 100,000 MW.

Government incentives

The Indian government can play an important role in encouraging the growth of alternative energy sources, not by giving cash subsidies but through other kinds of incentives.

At the rate at which new wind energy farms are being set up in India, its capacity from the wind will exceed 5,000 MW in less than two years, up from the present 3,595 MW

For instance, wind energy received a boost in Tamil Nadu last year when the Ministry of Textiles agreed to include wind farms in its Technology Upgrading Fund Scheme, which gives a subsidy of five per cent in the rate of interest on capital borrowed for upgrading textile mills. As a result, several textile mills in the state set up wind energy farms.

Even without such incentives, some industries have already recognised the potential saving from tapping the wind. Bajaj Auto, a company producing two-wheelers in the city of Pune, south of Mumbai, has set up a wind farm that writes off its entire electricity bill; several other industries are following its example.

India must take urgent steps to move away from fossil fuels in the face of the growing threat of global warming. Windpower can help both in this and in building energy security and self-reliance ■

Kalpana Sharma is Deputy Editor and Chief of the Mumbai Bureau of The Hindu.

Sugar Solution

MARCELO POPPE and **ISAÍAS MACEDO** describe the experience of the world's leading producer and consumer of biofuels

Ron Giling/Still Pictures

Sugar cane now provides 13 per cent of Brazil's energy, replacing fossil fuels with ethanol for transport and bagasse (waste pulp) for heat and power. It supplies: 180,000 barrels a day of ethanol, 400 per cent of all the gasoline used in the country; 17.5 megatonnes of oil equivalent (Mtoe) of bagasse as a fuel, equivalent to all the natural gas and fuel oil used in Brazil; and 9.7 TWh of electric and mechanical power, 3 per cent of the electric power generated.

Using sugar cane waste and efficient co-generation can add another 30 TWh of electric power, and implementing future processes to obtain ethanol from residue can increase production by 40 per cent from the same amount of cane. And planned increases in sugar cane production, will enable yet more of Brazil's energy to be met from this renewable source.

Market demand

Brazil is the world's leading producer of sugar cane, sugar and ethanol, growing sugar cane crops on five million hectares, a tenth of its cultivated land. There are around 60,000 crop suppliers, and 320 industrial units producing ethanol and sugar: driven by market demand, producers are themselves now building another 50 facilities.

Using ethanol for vehicle fuel began in the 1970's. Now more than 2.5 million cars run on it alone, and all gasoline sold in Brazil's 30,000 filling stations contains 25 per cent ethanol. In 2003, Brazil's car industry introduced flex-fuel cars – able to run on this blended gasoline, pure ethanol or a mix of both. just two years later they accounted for half the country's car production. In all, replacing gasoline with ethanol saved $60.7 billion between 1976 and 2004, or $121.3 billion when saved interest is taken into account.

Cutting costs

Producing ethanol in the most efficient mills in Brazil's Centre-South region costs about $0.20 a litre, equivalent to an international gasoline price of $25 a barrel, and lower than the costs of ethanol from corn in the US or from wheat and beet in Europe. There is now no price support mechanism under governmental policies for producing sugar and sugar cane in Brazil's Center-South region. There are no subsidies to production or trade, and no externalisation of costs to be paid by other sectors of society.

Costs have been cut by advances in technology and management, and by investment in infrastructure. Implementing existing technologies more broadly may reduce them further, but the greatest potential lies in technologies now being developed, including appropriate ag-ricultural practices, new transport systems, and genetic improvement.

Diverse crop

Brazil stands out from other producing countries for its sugar cane biotechnology: It has had had non-commercial transgenic varieties since the 1990's. In 2003, Brazilian laboratories completed identifying 40,000 sugar cane genes. Dozens of groups are working on the functional genome, and they are already using the genes in experimental genetic improvement programmes, and these may produce commercial results over the next years.

Brazil grows an increasingly diverse sugar cane crop, providing great security through resistance to exogenous diseases and pests. More than 500 varieties of sugar cane are now grown today, 51 of which have been released over the ▶

past decade. The twenty most important varieties occupy 80 per cent of the crop area, but the most common covers just 12.6 per cent of it.

Environmental benefits

The industry makes an important contribution to cutting local pollution and greenhouse gas emissions (GHG), and to the recovery of agricultural soils. Using ethanol has led to considerable improvements in air quality in urban centres, by eliminating lead from gasoline, reducing carbon monoxide emissions, eliminating sulphur and particulate matter, and emitting less toxic and photochemically reactive organic compounds.

It also avoids the equivalent of 13 per cent of the emissions of greenhouse gases from Brazil's entire energy sector — amounting to the equivalent of 33.2 Mt of carbon dioxide in 2003 alone. Every additional 100 Mt of sugar cane produced in future will cut emissions by a further 12.6 Mt.

At present sugar cane occupies just 0.6 per cent of land area, while at least 12 per cent of it could support the expansion of this kind of crop. A large proportion of Brazil's vast area of 850 million hectares enjoys conditions that will support agricultural production, while still preserving vast forest areas with different biomes. At present agriculture uses only 7 per cent of the country's territory (half of which is under soybean and corn crops), pastures use 35 per cent and forests 55 per cent. The expansion of sugar cane crops has taken place mostly in degraded pasture and "campos sujos" (grassland with some shrubs), rather than in forest areas.

So far sugar cane crops have had virtually no irrigation in Brazil. The amount of water withdrawn, and released, when they are industrially processed, has substantially de-creased from around 5 per cubic metre of per tonne of sugar cane collected in 1990 to 1.8 in 2004. Little fertiliser is used in comparison with sugar cane crops in other countries: 48 per cent more is used in Australia, for example. Nutrient recycling is being optimised, while the use of waste — which has yet to be implemented — will be very useful.

Specialised jobs

There are now 800,000 formal direct jobs in the industry, and the number is increasing; 90.4 per cent of those formally employed are aged 18 to 48, with only 0.3 per cent under 17. People working with sugar cane crops in the Centre-South, earn more than workers with coffee, citrus and corn crops, but less than those with soybean — which is highly mechanized, and provides more specialised jobs. In the North-Northeast, they earn more than those working with coffee, rice, banana, manioc, and corn crops, much the same as workers with citrus crops, and again less than those with soybean crops.

Mills maintain more than 600 schools, 200 daycare units and 300 walk-in care units. A survey of of 47 São Paulo-based units showed that more than 90 per cent provided health and dental care, transportation and collective life insurance, and over 80 per cent provided meals and pharmaceutical care. More than 84 per cent had profit-sharing programmes, accommodation and daycare units.

Brazil has an intermediate level of energy consumption with a strong focus on renewable energy sources: about 40 per cent of its energy comes from them, against 14 per cent in the world as a whole, and 6 per cent in OECD countries. As a result Brazil emits only 1.7 tonnes of carbon dioxide per tonne of oil equivalent, far below the world average of 2.4 tonnes. Its experiences helps show that ethanol is a real possibility for reliably suppling part of the world fuel market.

Renewable sources

Three quarters of the world's energy supplies come from fossil fuels. They are responsible for large local pollution loads and for most of the greenhouse gas emissions. The scale on which they are being used will quickly lead to their depletion, and energy consumption should grow as a result of the advance of many of the world's developing regions. Developed countries have not succeeded in reducing energy use without compromising the quality of life, even though it is known that this can and must be done. The challenge, therefore, is to seek renewable energy sources and to increase efficiencies in energy generation and use on an unprecedented scale ■

Marcelo Poppe is a former Secretary of State for Energy Development of Brazil, and Isaías Macedo, is a former Director of the Sugar Cane Technology Centre. Both advise the Centre for Strategic Management and Studies in Brasília.

■ ***Fourteen million students have learned about responsible energy consumption over the last decade through PROCEL, the Brazilian Government's energy conservation programme, implemented nationwide in partnership with the Ministries of Education and Energy, energy companies, UNEP and the non-governmental organization CIMA.***

■ ***Changing teachers' and students' attitudes towards energy consumption is increasingly imperative for reversing non-sustainable consumption trends, and the programme sees education as a main way of giving rise to a new pattern of energy use.***

■ ***A new edition of educational material will be released in 2006, and more than 15,000 public schools are expected to be involved in a 'PROCEL in the schools' initiative, which aims to prepare teachers to replicate training for reducing energy consumption in their schools. Teachers will then prepare technical materials and training kits for primary and secondary school students. Finally, energy companies will monitor the consumption of a selected roster of students engaged in the initiative, and awards will be given to the most successful.***

Clearing Away Carbon

PETER READ outlines a holistic strategy to use biofuels and carbon storage to return carbon dioxide in the atmosphere to pre-industrial levels

There is widespread concern that the world's climate is already witnessing precusors of abrupt (and immensly damaging) climate change, such as that possibly caused by continuing slowing of the Gulf Stream, which keeps Europe warm in winter. The thresholds for such changes are poorly understood and it may be that the only way to prevent dangerous climate change — the objective of the UN Framework Convention on Climate Change (UNFCCC) — is an early return to the pre-industrial levels of carbon dioxide in the atmosphere. That is inconceivable under the the Kyoto Protocol process, but it seems that it could be achieved by 2040 under a different, holistic approach.

The Protocol's theoretical basis assumes that emissions from human activities are the sole source of greenhouse gases. In fact the natural flux of emissions and absorption by the terrestrial biosphere is about twenty times as great. It is much easier to increase biotic fixation of carbon by investing in under-capitalised (and often over-exploited) land than it is to reduce emissions from the capital-intensive energy sector.

Polluter pays

The vision of this holistic greenhouse gas strategy is that the 'polluter pays' principle can be turned to a greening of the earth, to the advantage of developing countries with potentially productive soils. The strategy is the outcome of an expert workshop in Paris in 2004, funded by the Better World Fund on the policy implications of potential abrupt climate change (www.accstrategy.org). It concluded that "policy makers should be urged to create a global bio-energy industry with world trade in bio-fuels such as ethanol and bio-diesel" as the first part of a two-stage strategy to address potential abrupt climate change.

The second stage, to be implemented if such abrupt change became imminent, would achieve effective control of greenhouse gas levels on the timescale of a decade or so — rather than over centuries, as under the Kyoto Protocol. This control could be secured by linking the production of bio-energy to carbon storage. Growing biomass for energy would take up the gas from the atmosphere and, when the resulting bio-fuel was burned, some of the carbon dioxide would be prevented from getting back into it — through, for example, capture and sequestration technology at biomass-fuelled power stations and bio-refineries.

Science-based

The strategy is not based on any specific technology, as bio-energy systems are as varied as fossil fuels, and as there are also many ways of storing carbon out of the atmosphere. But it is science-based in the sense that it addresses the real problem of potential abrupt climate change by actively removing carbon dioxide from the atmosphere, unlike the broad band of zero-emission technologies promoted by the Kyoto Protocol that simply avoid emitting it. Done on a sufficiently large scale — and with care for environmental impacts — it could quickly get control of carbon dioxide.

The first stage offers benefits, rather than costs, to a great many interests. The only losers are the owners of land containing unconventional fossil fuels, like oil shales and tar sands, who would profit if energy companies exploited them.

For the energy sector such a transition to biomass raw material is no different from previous transitions from wood fuel to coal to oil to natural gas. It is far more easily assimilated than a shift to intermittent sources of non-fuel energy: 'defossilisation' is greatly preferable to decarbonisation. ▶

There are many environmental benefits. Firstly, large scale bio-energy makes far more ambitious reductions in net emissions of carbon dioxide possible than can be envisaged from the measures for capping emissions and trading carbon allowances under Kyoto, which are designed simply to reduce energy sector emissions. Secondly, a credible and rising obligation to use biomass raw materials will progressively re-direct energy investment towards them and away from expensive unconventional fossil fuels. And thirdly, large-scale investment in biomass supply brings with it the possibility of rectifying traditional neglect of the land and offers the prospect of cash flows that secure biodiversity, and enable reafforestation, soil improvement, anti-desertification and other environmental and social measures.

Energy security

There is no lack of land. Much biomass could come from focussing the existing management of forests and farms towards co-producing energy along with food and fibre. But Food and Agriculture Organisation studies show that there are around 2.38 billion hectares of unused potential arable land, much of it in the South, and especially in sub-Saharan Africa and Latin America. The shortage is not of land but of investment in land.

Large scale bio-energy production, traded internationally — mainly from developing countries to industrialised ones — offers advantages to most nations. It promises to give major oil-importing countries increasing energy security. It would provide alternative sources of income to Northern farmers that are compatible with WTO rules, and reduced burdens of farm support to their taxpayers. And cultivating biofuels offers many land-rich but cash-poor developing countries both a means of sustainable rural development and prospects of export-led growth based on trading them.

Large scale bio-energy production, traded internationally — mainly from developing countries to industrialised ones — offers advantages to most nations

The new approach — involving a commitment to sustainable best practice in improving land use - could be pioneered by a 'coalition of the winning' involving a group of initiators (say the G8 countries, the rest of the EU, China, India, Brazil, South Africa, Nigeria, Indonesia) which would progressively expand as others saw the advantage of participation. Such a coalition could commit to using a rising proportion of liquid bio-fuels for transport, mixing a rising proportion of woodchips or other biomass into fuel for power stations, and to supporting an increasing area of forest plantations to act as a strategic reserve of material, thereby making an early start on the removal of carbon from the atmosphere, needed for effective control of greenhouse gas levels.

Eventually, as Parties to the UNFCCC came to appreciate the merits of this science-based approach, it could become embodied in a second protocol, focused on potential abrupt climate change, which would be complementary to Kyoto and reinforce its effectiveness.

The negotiating community has inexplicably so far failed to notice the win-win-win possibilities of treating the carbon cycle as a whole in this way, rather than focusing on the very small fraction emitted by fossil fuel users. Let us hope that the vision behind this holistic strategy can inform future climate negotiations and set them in a more hopeful direction ■

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Evolve with us!

Young people are on the front lines of the dawning renewable energy revolution. We realise that building a renewable energy future will define our generation and that smart, farsighted action on climate change is an investment in our future.

One hundred young people from 26 countries came to a four-day International Youth Summit in Montreal at the start of the Conference of Parties to the UN Framework Convention on Climate Change and the Kyoto Protocol in Montreal. They said:

"We ask governments for a just transition to low-impact renewable energy and insist on the removal of fossil fuel subsidies. Human rights and social justice must be included in the transition from fossil fuel dependence. Projects involving nuclear energy, large-scale hydro-electric power and waste incineration do not contribute to sustainability. Carbon sequestration is a last resort to mitigating climate change."

This is just part of a growing movement of young people who are taking their future into their own hands. Across the globe, students and young people are leading grassroots efforts to purchase green energy, invest in sustainable transportation and complete retrofits and energy audits on campus and in local areas.

The North American youth renewable energy movement began with clean energy purchases on a handful of campuses in the mid-late 1990s. More than 80 educational institutions in North America are buying renewable energy, in the order of 500,000 MWH per year. More than 30 campuses have installed over 11 MWH of renewable energy and at least five institutions are completely powered by it. Hundreds of colleges and universities have joined the Campus Climate Challenge, a campaign to bring clean energy, like solar and wind, to campuses across the continent.

We know the problem. We also know that the solution lies in clean, renewable energy. We are capable of confronting climate change - and doing so is an opportunity to transform society for the better. The oil era is coming to an end and young people have already begun evolving toward a renewable energy future: we are vowing to make our own communities cleaner and more sustainable. We need our leaders to keep pace with our commitment, and we are calling on our governments to seize the moment and evolve with us ■

Elissa Smith (20) is President of the Canadian Youth Environmental Network and North American Representative on the UNEP Tunza Youth Advisory Council.

R. St. Robert/UNEP/Still Pictures